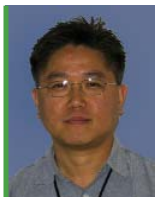
Modeling Production Plant Forming Processes



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LLNL has simulation tools and experience in modeling forming processes. DOE's Y-12 (Tennessee) personnel have expressed interest in validating our tools and experience against their manufacturing process activities such as rolling, casting, and forging. We have demonstrated numerical capabilities in a collaborative project with DOE and Alcoa that is nearing successful completion. The goal was to use ALE3D to model Alcoa's slab rolling process. We demonstrated a computational tool that would allow Alcoa to define a rolling schedule that would minimize the probability of ingot fracture, thus reducing waste and energy consumption. We intend this to lead to long-term collaboration with Y-12, and perhaps involvement with other components of the weapons production complex. Using simulations to aid in building forming processes can decrease time to production; reduce forming trials and associated expenses; and guide the creation of products with greater uniformity and less scrap.

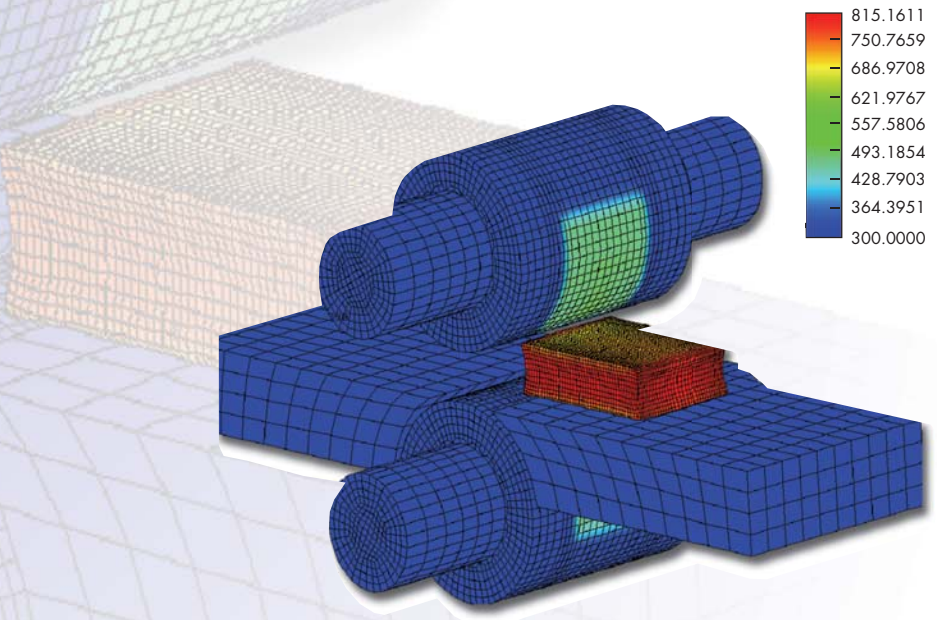

Figure 1. Illustration of a finite-element model representing rolls, slab, and supports. Thermal contours are shown.

Project Goals

The immediate objective of the proposed work is to use our numerical capabilities for rolling process validations and to foster a close collaboration with Y-12. We propose to validate our ability to model rolling experiments and assess our ability to address other forming processes at Y-12. The experience gained here would translate to other Laboratory projects.

Relevance to LLNL Mission

Modeling forming processes and material response is a significant responsibility of LLNL's Engineering Directorate. This effort will contribute to Engineering's core competency in numerical modeling and material response. The capability demonstrated in this project would be supportive of other forming projects where geometric fidelity and control of material properties are critical. A successful effort will also contribute programmatically to DNT objectives.

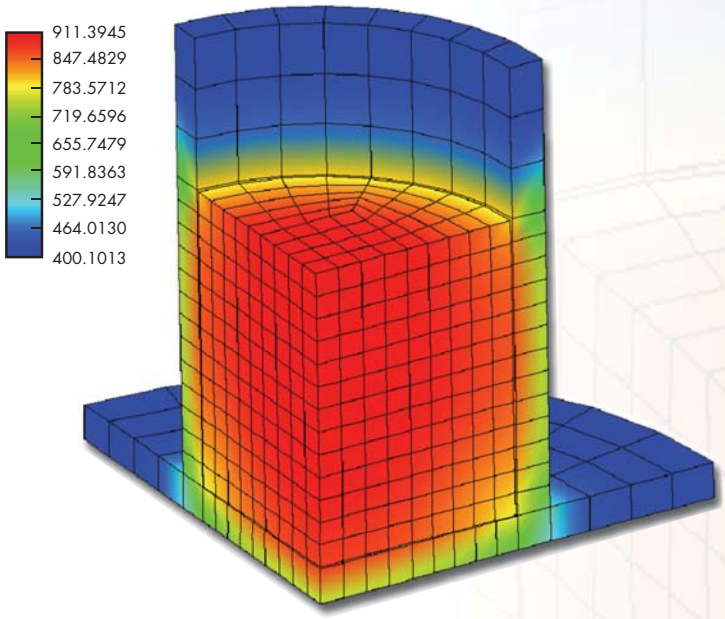

Figure 2. Illustration of a casting simulation showing thermal contours.

FY2004 Accomplishments and Results

LLNL personnel visited Y-12 to accomplish the following: familiarize ourselves with the suite of Y-12 forming issues (see Figs. 1 and 2), including advanced concepts, and identify areas where improved modeling might provide a significant benefit; and assess existing material properties data and identify approaches for filling gaps in knowledge.

The technical interchange at Y-12 was successful, yielding: information relevant to Y-12 modeling and forming processes; an agreement to collaborate on FY2005 technology-base activities; a path forward to produce a joint ADAPT proposal focused on understanding deformation forming processes.

We have performed a preliminary survey of high-temperature material properties for use in simulations, and have begun a series of calculations to evaluate the capability of ALE3D to model casting (Fig. 2).

An ADAPT proposal will be produced by the end of FY2004. The exit plan of this project is transition to an ADAPT-funded project in the future.

FY2005 Proposed Work

We will collaborate with Y-12 personnel to determine a rolling event and other forming data that can be used as validation data for our codes and techniques. We will attempt to predict microstructural evolution as well as geometric data. Knowledge of material properties relevant to forming regimes will be exchanged. Rolling validation calculations will be performed against rolling data from Y-12.

In our validation of ALE3D for reproducing rolling data, we are considering geometric fidelity and the evolution of microstructure.

Where appropriate we will perform code validation calculations, such as evaluating casting modeling codes against Y-12 specific data.